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Economic growth and Banking Stability nexus in crisis times

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ABSTRACT

This working paper seeks to confirm the existing evidence on the relationship between banking sector stability and economic activity. A Panel VAR model on 13 European countries for the period 1996 – 2014 is used. The level of banking sector stability is proxied by the Z-score, economic activity is represented by GDP growth while other variables are used in the model as controls. Analysing three distinct periods – i.e. 1996-2014, 1996-2006 and 2006-2014 – on two groups of countries – i.e. more and less stable –, the results demonstrate that while countries appear to behave similarly during calm periods, under more stressful times the outcomes turn out to be different.

Keywords Economic growth • Banking sector stability • Financial crisis • Z-score

1. INTRODUCTION

The last century has been marked by large episodes of banking crises. The first memorable one being the Great Depression occurring in the United States in the first half of the 20th century, spreading its consequences worldwide. By the end of the century, many other countries experienced banking instability leading often to large crises. While some improvements have been made with banking regulation to make the system safer, the last financial crisis highlighted the still existing fragilities of the financial structure. Indeed, at the time, the guidelines described in the two firsts Basel agreements showed strong weaknesses as they were not able to prevent bankers to take high risks and making poor decisions. In fact, from the early years of the 21st century, many loans considered as too risky were approved. While it has not been a problem for some years, 2007 showed the first potential fragilities and losses of the banking system. Widely known, the following quarters are noticeable for the panics, the credit crunches, many banks' failures and finally bailouts made by governments, triggering the Sovereign debt crisis in Europe. The main problem at the time was not because

of the failure of a single bank, but mostly the spread "infection" from one institution to the others as banks have a high level of interlinkage. Those banking crashes naturally led to strong economic downturns as not only people were facing high indebtedness, thus inducing losses for creditors, but also because less lending led to less investment and even less consumption. All of this, finally heading to a general contraction of the worldwide aggregate demand.

These episodes of banking crises and related economic downturn have increased the interest of many economists. While it has been hard for a long time to determine if one caused the other or if they reinforced each other, economists such as *Levine and Zervos (1998), Levine, Loyaza and Beck (2000)* or *Aghion, Howitt and Foulkes (2005)* showed that banking stability and economic growth are positively linked. Apparently not only, higher stability induces higher growth but also the opposite is true. Moreover*, Dell'Ariccia, G. Destragiache, E. And Rajan, R. (2007)* also shown that even though recession and banking crises episodes might not be directly linked, the latter seems to have extra negative consequences on the former. As a consequence, it appears to be extremely important to reinforce regulation in this sector, as we have seen in the past, fragilities might induce high costs for the worldwide economy.

Nevertheless, as far as it is known, studies on the relation of growth and banking stability have not been conducted in recent periods of high banking crises, such as for the Great Recession. As a result, this work project has the aim of studying these more troubled periods for the banking sector and assess if the results still hold. For this, I conducted a PVAR estimation on 13 European countries through 1996 until 2014. While some conclusions seem to hold, this thesis has reached some interesting results regarding the impact of the variables on each other, namely the impact of growth on the banking sector stability proxy in crisis times.

The rest of this work project is divided as follow: Section 2 presents some related literature on both the financial and the banking sector and section 3 describes the data used. In section 4, I present the methodology used for the estimation and in the subsequent section the outcomes of the latter. Finally, section 6 provides the main conclusions of the thesis.

2. LITERATURE REVIEW[1]

Goldsmith (1969) was one of the first economists to initiate the study on the influence of the financial sector on growth. In his assessment, he was able to provide results of a positive correlation between the development of the sector and the economy. As a first evaluation on financial development, *Goldsmith's (1969)* work failed in several aspects, one of the most relevant being the inability to deliver a causal interpretation between the financial sector and economic activity. This causality remained a strong issue in works presented by *King and Levine (1993)* and *Levine and Zervos (1998)* in which they were able to demonstrate that financial depth was a good predictor of economic growth and that the initial level of banking development was also positively correlated with futures rates of growth indicators. Later, *Levine (1998)* used legal determinants as an instrument to assess if the component associated with the legal characteristics of the banking development were related to economic indicators, namely GDP. The results showed a strong connection between this exogenous component and the long-run rates of growth, demonstrating that imposing legal reforms could be a driving motor for GDP growth. To complement this work, *Levine, Loyaza and Beck (2000)* used IV cross-sectional analysis and dynamic panel data models to be able to exclude potential simultaneity bias. Their findings show a strong relationship between the legal characteristics of the financial development and long-run growth, being able with this model to exclude any simultaneity bias or omitted country-specific effects. Later, *Aghion, Howitt and Foulkes (2005)*, questioned their work finding that indeed financial development was positively associated with the level of output, though having non-linear effects.

Additionally, studies at the industry level were also realised in order to deeply examine the relation between growth and finance. *Rajan and Zingales (1998), Claessens and Laeven (2005)* but also *Beck, Demirgüç-Kunt and Maksimovic (2004)* demonstrated that industries

[1] Part of the Literature Review has been found in *Levine (2004)*

relying heavily on external finance were strongly benefitted from an increase in financial development in their growth level. More specifically, *Beck, Demirgüç-Kunt and Maksimovic (2004)* showed that in countries with better developed financial systems, small firms were able to grow faster. *Kroszner, Laeven and Klingbiel (2007)* complemented the previous works by showing that in crises times the contrary occurs. That is, a disproportional negative effect on industries relying extensively on external resources.

As to this point, it was clear that efficient and sound financial sectors seemed to be determinant for a positive contribution to growth. *Creel et al. (2014)* tried to determine the relationship between economic performance and financial stability in the European Union. Using the GMM estimator introduced by *Arellano and Bond (1991)*, the authors found that financial depth was not significantly a positive contributor of economic performance and that indeed a limited effect of the latter existed, somehow confirming the results of *Aghion, Howitt and Foulkes (2005)*. However, they also concluded that financial instability was negatively linked to GDP growth independently of the effects of financial depth.

In an attempt to estimate the economic costs of banking crisis, *Boyd, Kwak and Smith (2005)* suggest that costs have been under-estimated. In fact, their findings demonstrated that after banking crises were resolved, there was high long-term output losses as the recovery was extremely slow. *Dell'Ariccia, Destragiache and Rajan (2007)* complete *Boyd, Kwak and Smith's (2005)* work with a study on industrial sectors. Since there was no clear evidence that banking problems resulted in lower output - as they state: "*the same exogenous shock might trigger both banking problems and a reduction in aggregate demand*" –, they tried to estimate if industries relying strongly on external finance were hurt more heavily during banking crisis. Their findings demonstrate that more dependent sectors grew relatively less than other sectors after the crisis is resolved. Therefore, showing that the same adverse shock affecting both the economy and the banking sector is accompanied by an additional cost on the economy. Finally, as to analyse the link between the banking sector stability and the evolution of real output

growth, *Monnin and Jokipii (2010)* used a panel VAR estimation for 18 OECD countries. In a first linear estimation, they found that there exists a two-way relationship. Not only higher growth promoted greater stability in the banking sector, but also a greater stability in the latter was followed by growth in the next periods. The results on the variance of both indicators were also interesting. Not only had both indicators a negative impact on their own variance – higher growth or stability followed by a reduced uncertainty – as they also discovered that a more stable sector was followed by a reduced uncertainty about future GDP growth. As for their non-linear estimation, defining three stages of stability, the results demonstrated that unstable sectors had a negative impact on growth, but that only unstable and very stable sectors had an impact on their own variance. Interestingly enough, when they extended their model by including other exogenous macroeconomic variables, growth was still dependent on stability while the contrary was not true anymore.

3. DATA

The data used in this work project consists of a balanced panel of macroeconomic series between 1996Q1 and 2014Q1 for thirteen European countries: Austria, Belgium, Denmark, France, Germany, Ireland, Italy, Netherlands, Norway, Portugal, Spain, Sweden and the United Kingdom. The variables considered for the analysis are GDP growth, the Z-score, Inflation and Long-term government bond yields. The Z-score was obtained through the FRED database and the remaining variables were extracted from the OECD. With the exception of the Z-score, all data is denominated in percentages.

3. 1 The Z-score indicator

In order to assess the banking sector stability, the Z-Score indicator is used. It is interpreted as the probability of default of a firm/bank in the following periods. It essentially compares the company's capitalization and returns with the volatility of those same returns with the following ratio:

$$\mathrm{Z-Score} = \frac{\mathrm{ROA} + \left(\frac{\mathrm{Equity}}{\mathrm{Assets}}\right)}{\sigma_{\mathrm{ROA}}}$$

The higher the Z-score, the more stable a bank is. Besides, in one of its first papers *Altman (1968)*[2] defined three thresholds when assessing the probability of insolvency. In fact, a firm with a Z-score greater than three can generally be interpreted as being in the safe zone – i.e. low probability of default in the next periods – while a Z-score below the 1.8 threshold is perceived as a firm in, or running into, financial distress - i.e. Bankrupt. The intermediate level being commonly called the grey zone[3]. In essence, a decreasing Z-score would be signalling an increasing stressing situation for the bank. Known to have a quite high accuracy in predicting bankruptcy in the following two years – i.e. 94% - it also presents some limitations. In fact, all data is directly extracted from the books values and therefore can be subjected to some accounting bias. However, the variable also presents the quality to be easily accessed while others might be harder to construct or collect[4].

The variable used in this work project consists of a weighted average of countries' individual banks Z-Scores – according to the amount of their assets on the total assets of the sector. Finally, because of the low frequency of the data – i.e. annually –, they were all transformed into quarterly data using linear interpolation.[5]

4. METHODOLOGY

As indicated in the Literature Review, a bidirectional relationship between GDP growth and banking sector stability- here proxied by the Z-score - appears to exist. Therefore, it seems suitable to use a Panel Vector Autoregressive model (PVAR) to estimate the link between those

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[2] Altman (1968) tested its first indicator on 66 US companies which were divided into two groups: Bankrupt and non-bankrupt. Using 20 years of data, he was able to "predict" which firms were going into financial distress and which were not in 94% of the cases.

[3] The only errors that occurred (misallocation of firms) were found in this range. Therefore, observing a company with a Z-score between those two thresholds would let us in the ignorance whether the firm is in fact going to be or not in financial distress.

[4] The Distance-to-Default indicator was first considered for the purpose of this work project. However, it turned out to be difficult to access all necessary data to create a consistent indicator.

[5] Since the data does not show any seasonality, a linear interpolation seems reasonable.

two variables. In fact, this setup allows us to take both the advantages of using the time-series and the cross-sectional framework. Moreover, as *Nickell (1981)* explains, using a simple dynamic Panel data model would introduce two different sources of persistence over time. The first one would be due to the lagged endogenous variables used as a regressor and the second would be characterized by the individual heterogeneity. As a result, using a simple OLS would create a biased and inefficient estimation due to the correlation with the error term. Likewise, as *Roodman (2006)* highlights, other estimators, such as using the Within transformation or GLS, would also not be able to solve the efficiency problem[6]. Furthermore, even though the first-difference transformation would take out the individual effect and the constant term, inefficiency would still arise. This is true not only because there would still exist correlation between the differenced lagged endogenous variable and the error term but also, as *Baltagi (1988)* underlines, because we are not using all available moment conditions. As a result, *Arellano and Bond (1991)* proposed the use of a GMM based on the work of *Anderson and Hsiao (1981)*[7]. In their setting, called system GMM, instead of only using the lags of the depend variable as instruments – as *Anderson and Hsiao (1981)* did –, they use the information in levels as additional moment conditions[8].

In a first stage, I estimate a linear model followed by a non-linear evaluation since some economist suggest that in fact the influence of banking stability is mainly non-linear.

4.1 Linear Panel VAR estimation

In order to estimate the PVAR I first test the order of integration of each series to determine if they are stationary. For this purpose, I use both the panel unit root tests from *Hadri (2000)* and *Im, Pesaran and Shin (2003)*. The former one allows for heteroskedasticity across

[6] The regressors and the errors would still be correlated, Roodman (2006).

[7] They proposed to use the second or third lag of the endogenous variable as instruments since by construction they would not be correlated with the error term but would be with the lagged dependent variable.

[8] Consistency of the estimator is based on the assumption that the error term is not serially correlated.

individuals while the second one permits to relax the assumption of cross-sectional independence. As anticipated, based on both tests, in levels none of the variables are stationary[9]. After differencing the data, the same tests were performed leading, as expected, to the conclusion of stationary first-differenced variables. Note that by differencing the data, the individual fixed effect is removed from the estimation. After first-differencing the variables, the PVAR can be written as follow:

$$(1)\ \Delta y_{it} = A(p)_{it-p}\Delta y_{it-p} + B(q)_{it-q}\Delta x_{it-q} + \Delta\varepsilon_{it}$$[10]

where y_{it} is the vector of the endogenous variables, A(p) is the coefficient matrix in the lag operator p, B(q) is the coefficient matrix in the lag operator q for the exogenous variables in the vector x_{it} and ε_{it} is the error-term with country i = 1, 2, …, N and the quarter t =1, 2, …, T. The vector y_{it} includes GDP growth and the Z-score indicator while the vector x_{it} is composed by the inflation rate and the long-term Government bonds' yields.

The forward orthogonal deviation model is used for estimation[11]. The selection of the optimal number of lags is done using the *Andrews and Lu (2001)* model and moment criteria based on Hansen's J-Statistic which selects one lag as optimal – this is true for every model estimated in the following sections.

5. RESULTS

5.1 Linear estimation

The results from the linear estimation are quite surprising. In fact, previous studies have demonstrated that there exists a two-way relationship between the banking sector stability and GDP growth. Though, we clearly see that it is not the case in this model.

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[9] *Hadri´s (2000)* test has for null hypothesis the stationarity – which is rejected. As for the *Im, Pesaran and Shin´s (2003)* test, the null hypothesis is no stationarity – which is not rejected.

[10] with Δ representing the first-differences i.e. $\Delta y_{it} = y_{it-}y_{it-1}$.

[11] Note that there is not much differences when applying first differences in the model. Though, as *Roodman (2006)* states, compared to FD, FOD minimizes data loss as it subtracts the average of all future values.

As it can be seen, both the lagged values of GDP growth and Z-score have an effect on their subsequent variable – at the 1% level for the two indicators. However, according to Table 1, the variables have no significant impact on each other, contradicting therefore previous results on the effect of the banking stability on growth. Furthermore, one can also see from the table that the level of inflation affects negatively the current level of growth while the constant enters significantly for the Z-score estimation. Also note that long-term Government bond yields do not impact significantly the level of growth. Yet, it would have been expected to find a significant relationship between the latter and GDP.

TABLE 1: LINEAR ESTIMATION

	GDP	**Z-score**
GDP_{t-1}	*-0.5266****	-0.0058
	(0.0504)	(0.0103)
$Z\text{-score}_{t-1}$	0.0068	*0.6774****
	(0.0261)	(0.0154)
Inflation	*-0.0713**	0.0190
	(0.0396)	(0.0194)
Long -Term Government bonds yields	-0.0222	-0.0080
	(0.0343)	(0.0158)
Constant	-0.0052	*0.0158****
	(0.0039)	(0.0048)

*** p < 0.01, ** p < 0.05, * p < 0.1

In a second step, I analyse the generalized impulse response functions of both variables to see how an exogenous shock influences each variable[12].

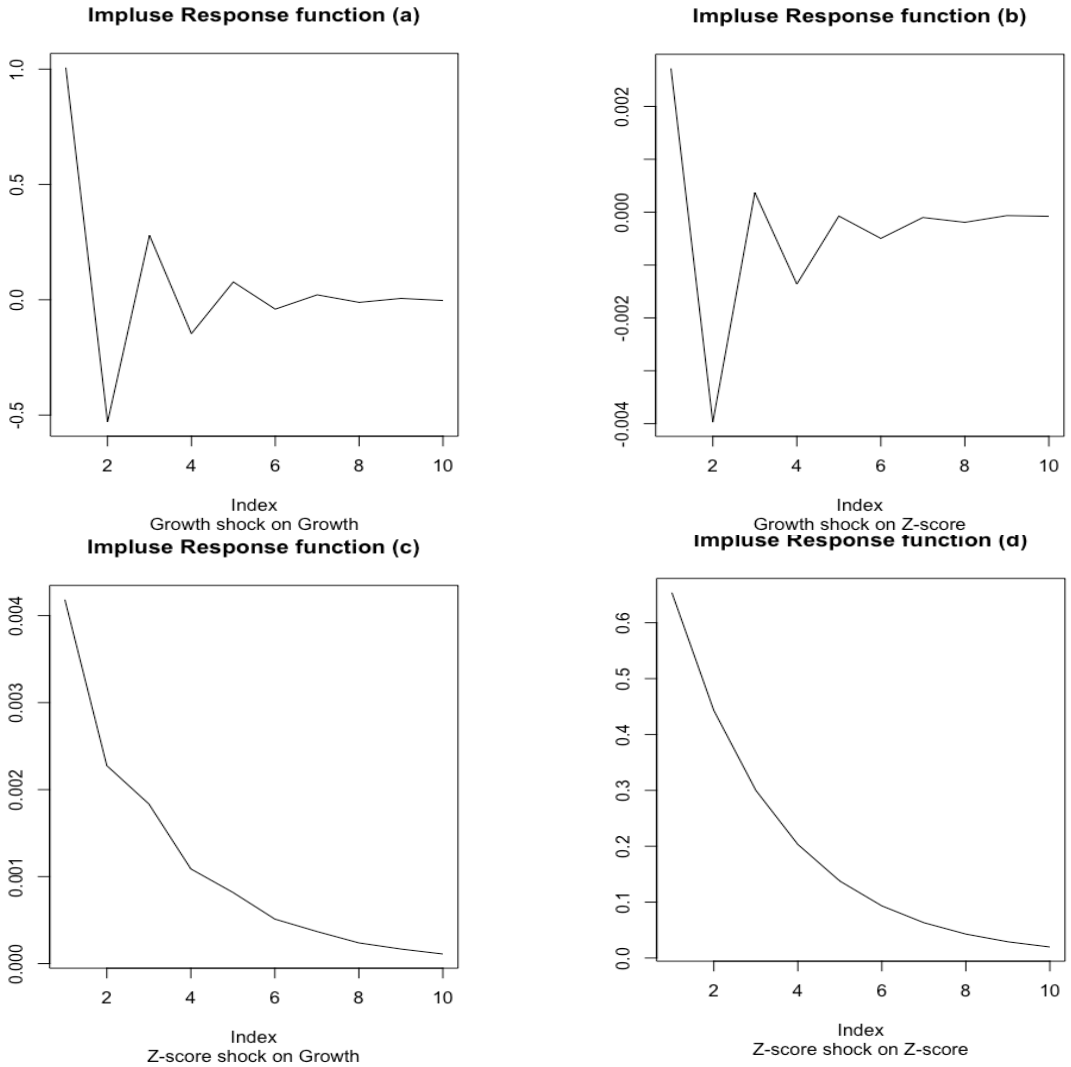
The upper part of Figure 1 presents exogenous shocks to GDP on both GDP and Z-score for the linear model. In the former case, we observe that one standard error shock to GDP on its own variable causes a cyclical behaviour which seems to stabilize after more or less eight quarters, firstly having a positive impact on the variable – a shock of one standard error originates a full impact on growth. As for its effect on the Z-score, we also observe an oscillatory response from the exogenous shock, with a diminishing amplitude over time – the shock initially originates a change of 0.2% on banking stability. This latter result is quite

[12] According to *Pesaran and Shin (1998),* the GIRF do not depend on the ordering of the VAR.

surprising as previous studies have found a strong positive impact of a growth shock on banking stability which was long lasting over time.

In the lower part of Figure 1, we have the results of an impulse of one standard error of Z-score on both variables. For the growth's case, the response is positive and keeps losing strength as time increases, fading after ten periods. In fact, having an exogenous improvement in the banking sector stability is likely to increase confidence in the financial sector, stimulating

FIGURE 1: IRFS FROM THE LINEAR MODEL[13]



[13] In Figure A2 in the Appendix the IRFs are presented with confidence intervals.

investment and capital accumulation, thus economic growth. Even though this result can make sense in theory, one should note that the impact of a Z-score shock on growth is also very marginal – i.e. 0.4%. Finally, the impact of an exogenous Z-score shock on its own has also a diminishing positive effect over time, vanishing after fifteen periods – the impact is also much larger than in the previous case as one standard error shock has a direct impact of 70% on banking stability.

After analysing the IRFs, it can be concluded that growth and banking stability seem to have very marginal effects on each other. Also, exogenous shocks whether they come from banking stability or growth have a very similar pattern on both variables. Finally, a Z-score's shock also appears to be more persistent over time – whether the shock is on growth or on itself[14].

5.2 Non-linear estimation

Some economists believe that the effect of the banking sector stability on growth is in fact non-linear. For instance, in their assessment of finance's effect on growth, both *Cecchetti and Kharroubi (2012) Beck* and *Georgiadis And Straub (2014)* found that financial development has a positive effect on growth but only up to a certain point. The banking segment being one of the fundamental parts of the financial sector, it seems appropriate to study if it also has a non-linear impact on economic growth. In this sense, *Monnin and Jokipii (2010)* decided as well to estimate the non-linearity of the banking sector. Denominating three different states, they were able to find that only unstable sectors had an impact on growth while stable and very stable had not. In a similar approach, I decide to create a Dummy for the Z-score which describes two states of the banking sector: a distress state and a stable state, i.e.,

$$D_{it} = \begin{cases} 1 \text{ if in Distress} \\ 0 \text{ otherwise} \end{cases}$$

[14] Around ten quarters while growth shocks have effects until after two years.

A bank is considered in the safe thresholds when its Z-score is above 2.99. However, when observing each country's indicator, it appears that only Ireland does not fulfil this criterion. In fact, for 1999Q4-2001Q1 and 2007Q3-2010Q3 Ireland's Z-score remained below 2.99. Moreover, as seen in Figure A1 in the Appendix, one can see a great disparity when comparing countries' Z-scores. For instance, Austria, Denmark, Germany, France, Italy and Spain's indicators never get below ten – yet, also experiencing more volatility in periods of economic stress. To solve this issue, I choose to standardize the banking sector stability indicator. After the transformation, the indicator's values are found between -2.3 and 4.55. I resolve to consider the distress threshold in the first 15%[15] - i.e. at -1.25. This level only includes 127 of the 936 observations with merely three countries– i.e. Ireland, Netherlands and the United Kingdom. There are several reasons for the low scores of those three countries. For instance, it is known that Ireland had a considerable real estate bubble with banks providing substantive property lending. Also, in the past decades, the British and the Dutch banking sector have seen a large increase in their assets – due to a growing banking sector. This could be a simple explanation for those small Z-scores. Though, we could also mention the same arguments for other countries, such as Spain – among others – which was also known for its real estate bubble in the years preceding the financial crisis.

To analyse the impact of financial distress on the level of the economy, I resolve to estimate the following non-linear model:

$$(2)\ \Delta y_{it} = A(p)_{it-p}\Delta y_{it-p} + B(q)_{it-q}\Delta x_{it-q} + D_{it} + \Delta\varepsilon_{it}$$

Being very similar to the linear model, I now include the dummy variable D_{it}, which is defined by the two possible states. After testing for unit-roots, it also appears that the data is stationary in first differences. The PVAR analysis leads us to the results presented in Table 2. As one can

[15] In the literature, it is common to choose the threshold in the first 15-20%.

see, most of the coefficients are similar to the linear model[16]. Again, there does not exist a significant bidirectional relationship between the two dependent variables. However, now we can observe that the dummy variable enters significantly for the growth equation. In fact, a banking sector's country evaluated as in distress impacts negatively the level of growth – i.e. minus 0.2335 – which is not surprising. Finally, we could have expected a negative relationship between the dummy variable and the Z-score as a distressed banking sector should reinforce a reduction in the latter. Though, according to the estimation, even not being significant, this is not the case.

TABLE 2: NON-LINEAR ESTIMATION

	GDP	**Z-score**
GDP_{t-1}	*-0.5281***	-0.0057
	(0.0507)	(0.0103)
$Z\text{-score}_{t-1}$	0.0036	*0.6777***
	(0.0270)	(0.0155)
Inflation	*-0.0714**	0.0190
	(0.0396)	(0.0194)
Long -Term Government bonds yields	-0.0193	-0.0082
	(0.0352)	(0.0159)
Banking Instability Dummy	-0.2335***	0.0110
	(0.0295)	(0.0283)
Constant	-0.0129	*0.0149***
	(0.0144)	(0.0060)

*** p < 0.01, ** p < 0.05, * p < 0,1

The impulse response functions are not displayed here since they are essentially equivalent to the ones found with the linear model[17]. The only small difference occurs in a Z-score innovation on growth – the effect keeps being positive, but it is less smoothed.

5.2.1 Restricted sample

In order to confirm the previous results, I decided to restrain the time span to be more focused on the 2008 subprime crisis and the succeeding sovereign debt crisis. For this, I chose

[16] I also estimated the model considering the first 20% as the distress threshold – i.e. at -0.91. The results are essentially the same yet with a smaller magnitude. Note also that with a 20% threshold, the dummy has a minor impact on growth – minus 0.0254 at the 1% level.

[17] Though, the IRFs are presented in the appendix, in Figure A3

to analyse the series from 2006Q1 to 2014Q1. Following the previous steps, standardized Z-scores located in the first 15% of the sample are chosen as distress points – only 24 on a total of 429 observations fulfil this criterion. Here, as it was previously the case, the same three countries are considered having an unstable banking sector. Moreover, I also introduce a dummy variable to take into account the financial crisis – i.e. the dummy is equal to one for 2007Q4 until 2009Q2 and zero otherwise. The non-linear estimation on the restricted sample is presented in Table 3.

TABLE 3: NON-LINEAR ESTIMATION WITH RESTRICTED SAMPLE

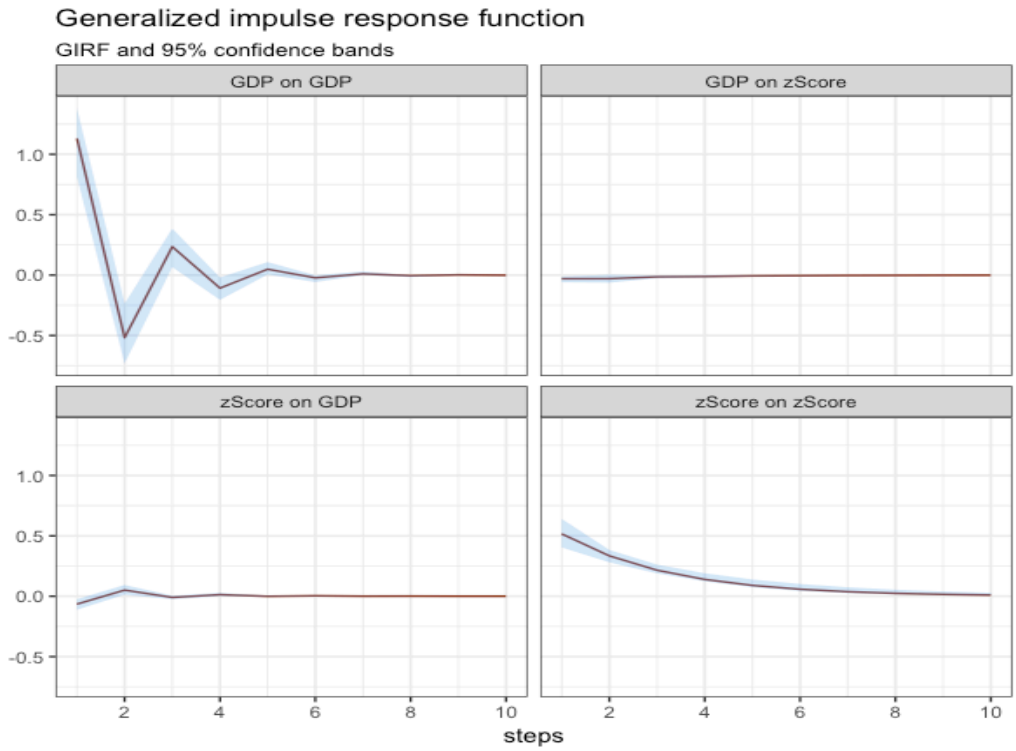
	GDP	**Z-score**
GDP_{t-1}	*-0.4566****	-0.0090
	(0.0629)	(0.0131)
$Z\text{-score}_{t-1}$	0.0409	*0.6460****
	(0.0647)	(0.0424)
Inflation	-0.0730	0.0438
	(0.1255)	(0.0327)
Long -Term Government bonds yields	*-0.0211*	-0.0342
	(0.0922)	(0.0256)
Banking Instability Dummy	*-0.2516****	0.0610
	(0.0832)	(0.0777)
Financial Crisis	-0.3059***	*0.1364***
	(0.0520)	(0.0466)
Constant	0.0615***	-0.0173
	(0.0143)	(0.0212)

*** P < 0.01, ** P < 0.05, * P < 0.1

When compared to the previous non-linear estimation, one can see that both dependent variables have a less extended impact on their respective subsequent variables. As expected, confirming the previous estimation, the results clearly demonstrate that a country with an unhealthy banking sector has a negative influence on growth. In fact, due to the closeness to the crisis, we see that the coefficient of the Dummy representing banking distress is slightly higher than in in the regular non-linear estimation. Curiously enough, while the dummy for the Financial crisis enters negatively and significantly for growth, it has a positive and significant impact for the Z-score, suggesting that the financial crisis had a positive effect on banking stability – This issue will be discussed in the following sections.

One interesting feature of the restricted estimation remains in the analysis of the generalized impulse response functions. The first striking difference lies in the effect of a banking stability exogenous shock on growth. In fact, while previously the effect was positive and gradually diminishing, here there is an immediate negative impact. Though, also showing a leger cycle, after one period the effect turns out to be marginally positive, completely vanishing after two years. Also note that in the second quarter – when the shock starts having a positive influence –, the effect is ten times stronger than in the linear case – i.e. 4% versus 0.4%. Thus, it appears that even though there is a certain adjustment occurring during the first quarter, the stability innovation has eventually a much stronger impact on growth during

FIGURE 2: IRFS FROM THE NON-LINEAR ESTIMATION ON THE RESTRICTED SAMPLE[18]



periods of crises. Besides, a one standard error shock to growth has also a peculiar effect on banking stability. In fact, the shock has a clear negative, though diminishing, impact on the level of the Z-score – while in the previous two cases there was a cyclical behaviour. Contradicting economic theory, it appears that while more centred in the crisis, even a positive

[18] Figure A4 in the Appendix presents the IRFs with different scales.

growth shock will initially deteriorate the level of Z-score. At this stage, it is somehow hard to understand why this is the case. Moreover, while a growth innovation appears to have the same influence on its own, an exogenous shock to the banking sector stability indicator has a slightly lower magnitude –i.e. an increase of 50% in the present case while it was 60% in the linear and non-linear model.

5.3 Different Groups

Due to the high disparity existing in each country in terms of Z-scores – see Figure A1 in the Appendix–, I also choose to analyse countries in different groups. For that, I divide them into two sets: Group 1 is constituted of countries with the lowest Z-scores – i.e. Belgium, Ireland, Netherlands, Norway, Portugal, Sweden and the United Kingdom -, while the second group is formed by countries with, in general, Z-scores higher than 15 – i.e. Austria, Denmark, France, Germany, Italy and Spain.

The methodology used is the same as in previous estimations[19]. Examining the non-linear impact, in both groups I obtain the results presented in Table 4.

Focusing firstly on Group 1, we see a clear difference in the estimation. In fact, as it can be observed in the left part of the table, while both lagged dependent variables still enter significantly for their contemporaneous variables, now the lagged Z-score has also a negative significant impact on growth. This suggests that in this sample, higher stability influences negatively economic growth. Moreover, Long-term government bond yields and the banking instability dummy also enter significantly for the growth equation.

When considering Group 2, one can observe distinct results. The first striking difference happens in the impact of the lagged Z-score. Conversely to Group 1, the lagged value of the indicator does not enter significantly for the growth equation. Moreover, the Banking distress dummy also does not influence significantly growth while – as in the restricted estimation – it

[19] The Z-scores are standardized in each Group. The threshold of the first 15% are -0,8 and -1,24 for Group 1 and 2 respectively. Moreover, in order to be stationary, the variables are also differentiated.

has a positive and significant impact on banking stability – which is quite odd. Apart from this, we can also observe some different magnitudes in the coefficients.

TABLE 4: NON-LINEAR ESTIMATION FOR THE TWO GROUPS

	GDP *Group 1*	**Z-score** *Group 1*	**GDP** *Group 2*	**Z-score** *Group 2*
GDP$_{-1}$	*-0.5682****	-0.0069	*-0.3818****	0.0010
	(0.0419)	(0.0111)	(0.0850)	(0.0272)
Z-score$_{-1}$	*-0.0401****	*0.6952****	0.0457	*0.6527****
	(0.0117)	(0.0122)	(0.0356)	(0.0378)
Inflation	-0.0644	0.0134	-0.0729	-0.0827
	(0.0463)	(0.0239)	(0.0658)	(0.0546)
Long -Term Government bonds yields	*0.2397***	0.0243	0.1894	-0.0232
	(0.1182)	(0.0221)	(0.1246)	(0.0804)
Banking Instability Dummy	*-0.3332****	0.0092	-0.1558	*0.1177**
	(0.0668)	(0.0231)	(0.1426)	(0.0539)
Constant	0.0619	0.0174	0.0170	-0.0005
	(0.0378)	(0.0089)	(0.0134)	(0.0116)

*** p < 0.01, ** p < 0.05, * p < 0.1

The results of the impulse response functions are also very interesting. Focusing firstly on the group with higher stability, one can notice a high similarity with the restricted analysis. Despite having slightly different magnitudes, it appears that the variables have almost the same behaviour when reacting to exogenous shocks[20]. Note that the Group analysis is completed using the whole sample – i.e. from 1996 to 2014.

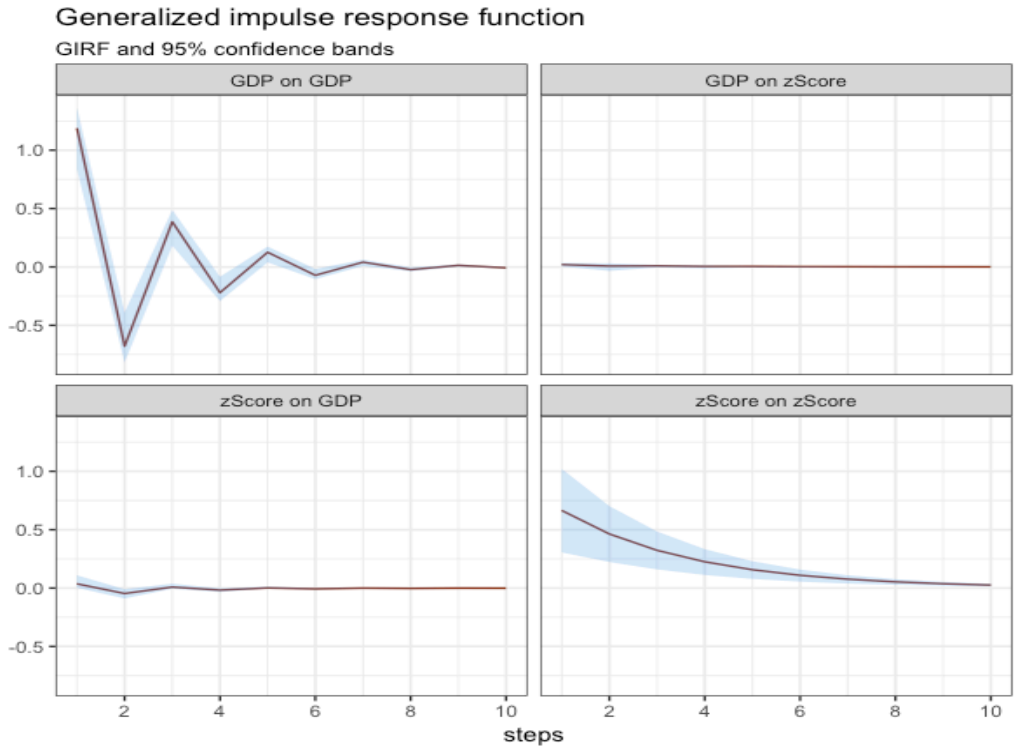
Considering now Group 1 in Figure 3, one can clearly distinguish two main differences[21]. First, concerning a growth's shock on banking stability one can observe the opposite impact. In fact, according to Figure 3, a growth innovation seems to influence positively the banking stability indicator[22] – which in theory seems to be logic. Being also very marginal, the effect is diminishing over time – initially one standard error shock to growth has an impact of 2% on banking stability. Besides, there is also a relevant difference concerning the banking stability exogenous shock on growth. When compared to Group 2, it looks like the

[20] Due to the similarity with the restricted estimation the IRFs are presented in Figure A5 in the Appendix.

[21] In Figure A6 in the Appendix, I present each shock with different scales.

[22] There is a better visualization in Figure A6 (Appendix)

FIGURE 3: IRFS FROM GROUP 1



impact is asymmetric. For the less stable group, the shock turns out to have an initial positive impact on growth, oscillating afterwards around zero – before completely vanishing after ten periods. Interestingly enough, the behaviour is almost a copy of a growth shock on its own – though, with a much lower amplitude since the impact here is of 2%. This suggests that in more fragilized countries, growth reacts similarly to either a shock to Z-score or to growth.

The results on the different groups suggest that not only Group 2 has a preponderant impact in the sample – especially during crises –, as it appears that the crisis itself has also a preeminent effect on the entire analysis of Group 2 as the conclusions are essentially the same.

5.3.1 Pre-Financial Crisis

From the previous analysis, one can conclude that there does not only exist a disparity in the countries' Z-scores, but also in the responses of the groups to different shocks. Moreover, while in the first group, responses from shocks appear to have a theoretical explanation, Group 2 displays odd results. To understand where these disparities come from, I also decided to divide each group in two distinct periods: Pre-Financial Crisis and During/Post Financial Crisis.

First, using the same approach as in previous models, I conducted an estimation from

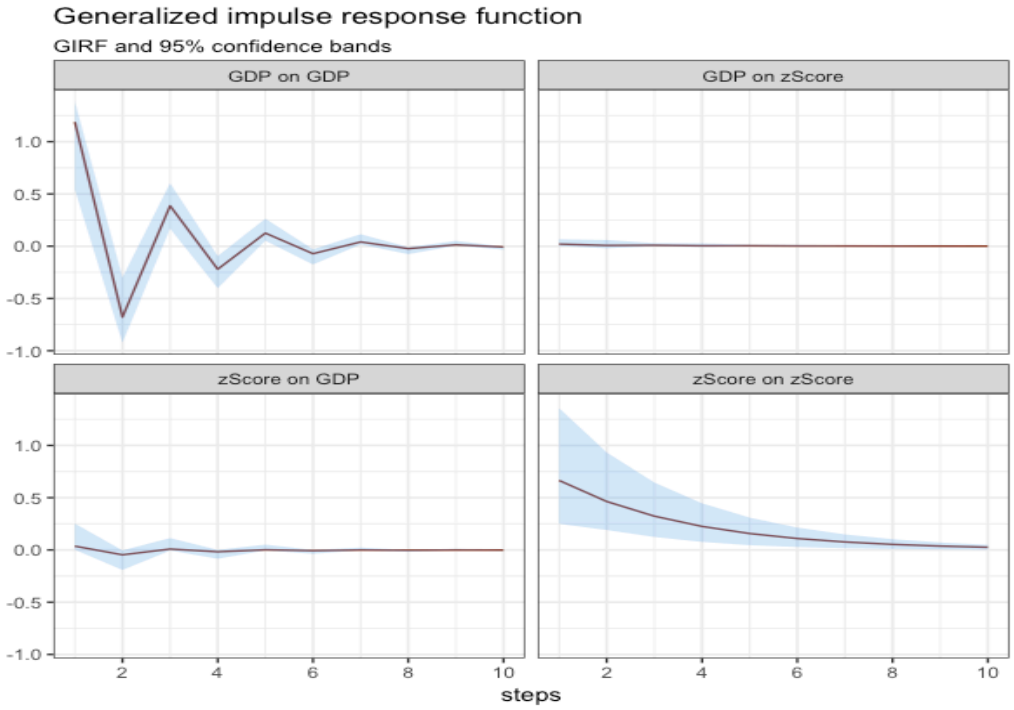
TABLE 5: NON-LINEAR ESTIMATION FOR BOTH GROUPS – PRE-FINANCIAL CRISIS

	GDP *Group 1*	**Z-score** *Group 1*	**GDP** *Group 2*	**Z-score** *Group 2*
GDP$_{-1}$	*-0.6402****	-0.0003	*-0.4913****	0.0152
	(0.0195)	(0.0149)	(0.0690)	(0.0142)
Z-score$_{-1}$	-0.0189	*0.6931****	-0.0074	*0.6675****
	(0.0201)	(0.0101)	(0.0103)	(0.0192)
Inflation	-0.2414***	-0.0093	-0.3042***	-0.0130
	(0.0664)	(0.0766)	(0.1092)	(0.0432)
Long -Term Government bonds yields	*0.4481**	-0.0504	0.3724***	-0.0305
	(0.2604)	(0.0549)	(0.0810)	(0.0989)
Banking Instability Dummy	0.0711	-0.0204	0.0006	0.0155
	(0.1277)	(0.0156)	(0.0155)	(0.0258)
Constant	0.0364*	-0.0024	0.0357***	0.0197
	(0.0216)	(0.0125)	(0.0135)	(0.0211)

*** p < 0.01, ** p < 0.05, * p < 0.1

1996Q1 until 2005Q4 – Pre-Financial Crisis. As it can be seen in Table 5, the results from both groups have essentially the same interpretation, though with leger changes in the magnitudes. Note that in this analysis, the Dummy for the banking instability is insignificant for both groups as during this period there was no significant banking distress – It is also seen in the Appendix in Figure A1 which displays relatively stable Z-scores before the crisis.

FIGURE 4: IRFS FROM THE NON-LINEAR ESTIMATION PRE-FINANCIAL CRISIS – GROUP [23]



[23] Since Group 2 has very similar outcomes, I decided to not display the IRFs

Additionally, the analysis of the IRFs also allow us to conclude that, while there exist some differences regarding the magnitude of the shock, the variables' behaviour is very similar – i.e. as seen in Figure 4 the impact is overall positive for all cases.

5.3.2 Financial Crisis

While it appears that both groups of countries react similarly in relatively calm periods, they do show distinct results when the economy is under stress. In fact, when analysing the period around the financial crisis, we obtain the results presented in Table 6. First, the banking instability dummy only enters significantly for GDP in Group 1. Though, as the result is positive it suggests that banking instability impacts positively GDP in those countries, an outcome that goes against economic theory. Moreover, as expected, we see that the financial crisis plays an important role in GDP. Nevertheless, the latter appears to enter positively in the Z-score estimation which has already been seen in the restricted estimation.

TABLE 6: NON-LINEAR ESTIMATION FOR BOTH GROUPS – FINANCIAL CRISIS

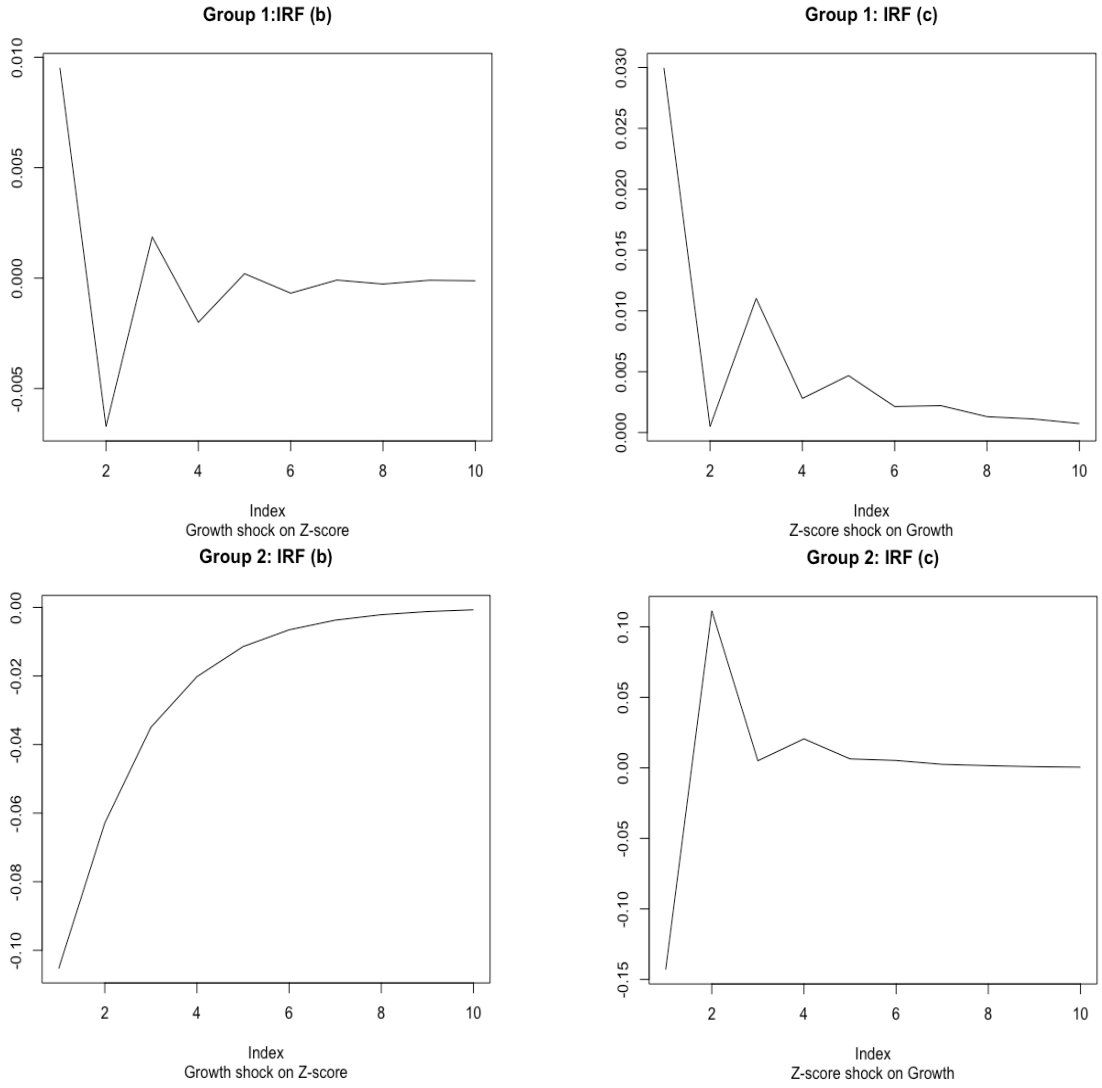
	GDP *Group 1*	**Z-score** *Group 1*	**GDP** *Group 2*	**Z-score** *Group 2*
GDP$_{-1}$	*-0.4960****	-0.0102	*-0.3034****	-0.0035
	(0.0626)	(0.0091)	(0.0854)	(0.0486)
Z-score$_{-1}$	0.0360	*0.7343****	0.1139	*0.5704****
	(0.0580)	(0.0243)	(0.0748)	(0.0733)
Inflation	0.0295	-0.0411	0.0355	-0.1353
	(0.0824)	(0.0250)	(0.0462)	(0.0908)
Long -Term Government bonds yields	0.1128	0.0430	0.0664	-0.0604
	(0.1288)	(0.0288)	(0.2344)	(0.1046)
Banking Instability Dummy	*0.4225****	0.0173	-0.0681	0.0942
	(0.0578)	(0.0335)	(0.0997)	(0.1062)
Financial Crisis Dummy	*-0.2715****	*0.1137***	-0.3095***	0.1504**
	(0.0830)	(0.0480)	(0.0563)	(0.0567)
Constant	0.0301	0.0122	0.0512**	-0.0620**
	(0.0297)	(0.0146)	(0.0208)	(0.0297)

*** p < 0.01, ** p < 0.05, * p < 0.1

Nonetheless, the GIRFs analysis display very interesting results. In fact, it can be seen in Figure 5, that it is exactly where both groups have divergent outcomes. Group 1 has coherent and very similar responses towards shocks as the regular non-linear estimation – slightly lower magnitudes. As a matter of fact, one standard error shock to growth has a cyclical behaviour on

the Z-score while an exogenous stability shock has a positive and diminishing impact on growth.

FIGURE 5: IRFS FROM THE NON-LINEAR ESTIMATION FINANCIAL CRISIS – GROUP 1& 2[24]



Though, Group 2 displays outcomes very similar to the ones found in the restricted and Group 2 analysis, with a much higher magnitude – i.e. initial impact of minus 15% of a Z-score innovation on growth and minus 10% effect of an exogenous growth shock on banking stability, while it was respectively minus 6% and 3%. It appears somehow that Group 2 has a very odd behaviour during crises as the responses from shocks have no economic theory explanation.

[24] I only present the GIRFs from an exogenous shock to GDP on Z-score and to Z-score on GDP since that is where the main divergences come from. The remaining ones are presented in the Appendix in Figure A7.

Nevertheless, Group 1, with less stable countries, appears to behave according to what is expected – i.e. variables respond positively to shocks.

6. CONCLUSION

Throughout this work project I analysed what was the influence of GDP growth on the banking sector's stability and vice versa. The results seem to agree with, and confirm, outcomes previously reached in this domain of research. In fact, it appears evident that there exists a non-linear effect between both variables. This conclusion is reached when comparing linear and non-linear estimation. As a matter of fact, while the lagged values of both dependent variables might not enter significantly in the estimation of the other variable – suggesting that there is no direct bidirectional effect –, the negative and significant impact of the banking distress dummy implies that countries experiencing such situations see their economic activity affected by the latter. Later, when I focused the estimation in the financial crisis, distinct outcomes were established. There, the GIRFs demonstrated that growth impacts negatively banking stability – which does not make economic sense. Dividing the sample in two distinct stability groups to understand why, I reached interesting results. In fact, while both kind of groups react similarly in relatively calm times – i.e. from 1996 until 2006 –, they react very differently in stressful periods. In fact, in the first estimation, it is found that exogenous shocks from both variables had overall a positive effect on the other – with slightly different magnitudes. However, regarding the period of crisis, it is found that the most stable group has a very similar reaction towards shocks as in the restricted estimation.

This result demonstrates several important points. First, it appears that Group 2 has a preponderant effect on the sample as its results during the crisis are very much alike the ones with all countries. This actually has a sensible explanation since I did not use countries fixed effects. Moreover, this outcome also demonstrates that the crisis had also a preeminent effect since the results coming from Group 2 – from 1996 until 2014 – are essentially the same.

Finally, the outcomes reached by Group 2 do not have a proper economic explanation since it appears that growth has a negative effect on the Z-score and that the opposite, despite overall being positive, is also true. Nevertheless, when observing both the level of the Z-score and GDP growth for this group, one can see that the Z-score only slightly varied during the crisis. Besides, GDP growth for that cluster had much less variation than the one in the first group. This can therefore explain why there exists this negative effect of growth on banking stability, but also why the banking distress dummy and the Financial crisis dummy – for certain estimations– had a positive impact on the banking sector's stability. Nevertheless, the outcomes reached in this work project agree with the point that, even being marginal here, there is in general a mutual and positive influence between GDP growth and banking stability.

The latest fact clearly demonstrates that the Z-score indicator might not be the best proxy to use for banking sector stability – not only because of the results but also due to its behaviour as observed in Figure A1 in the appendix. Nevertheless, as stated before, it was very difficult to create a consistent estimator such as the Distance-to-Default as there was little information available.

Nevertheless, the overall results found in the work project support the view that banking regulation and supervision should be enhanced and regarded as a crucial aspect for sound economic activity. An issue that appears to have been taken into account by the European Union since the Basel III agreements are now being gradually implemented throughout the Union to fill the blanks that have been left by its two predecessors.

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7. APPENDIX

FIGURE A1: Z-SCORES

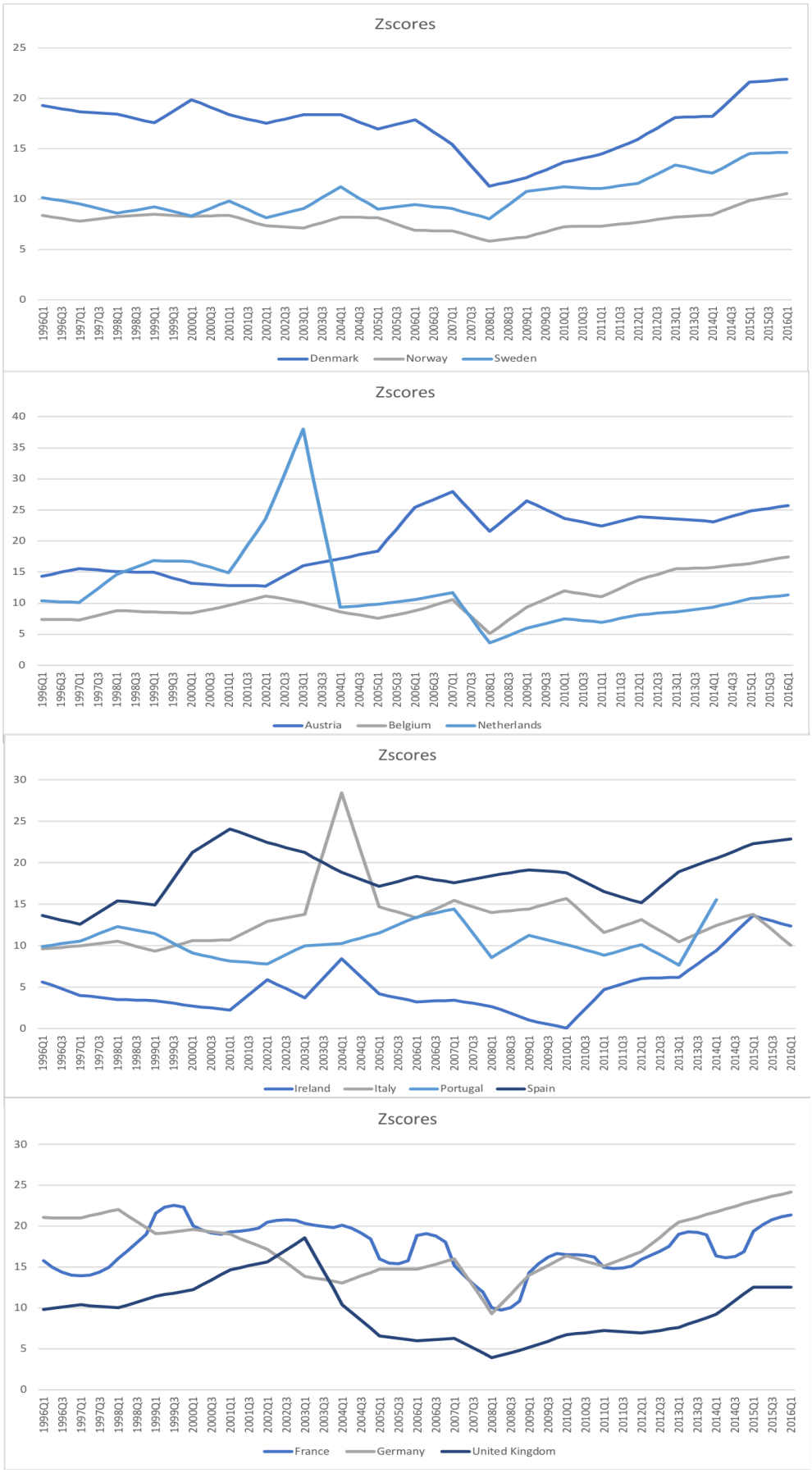

FIGURE A.2: LINEAR ESTIMATION

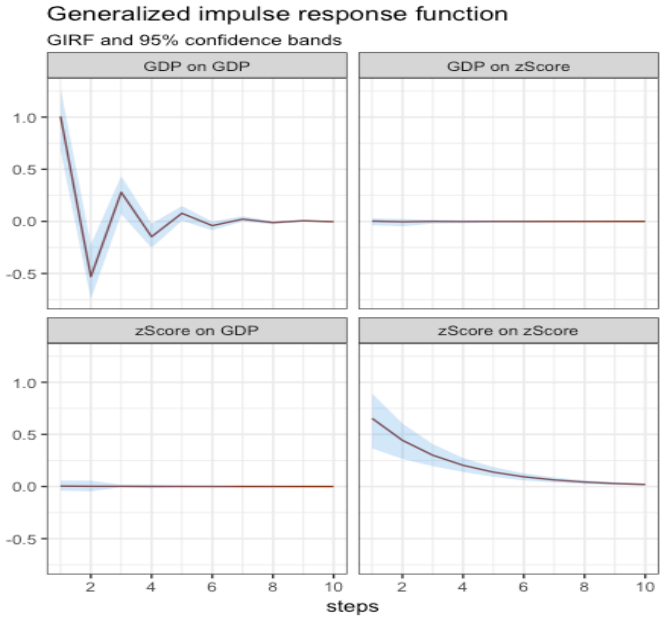

FIGURE A3: NON-LINEAR ESTIMATION

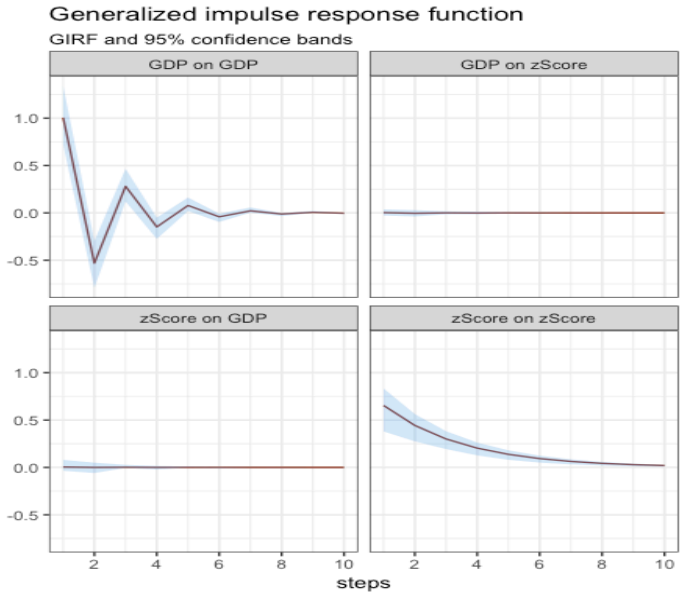

FIGURE A3.1: NON-LINEAR ESTIMATION – Z-SCORE SHOCK ON GROWTH

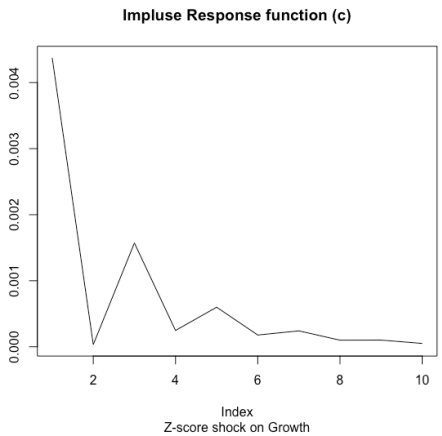

FIGURE A4: IRFS FROM THE NON-LINEAR RESTRICTED MODEL

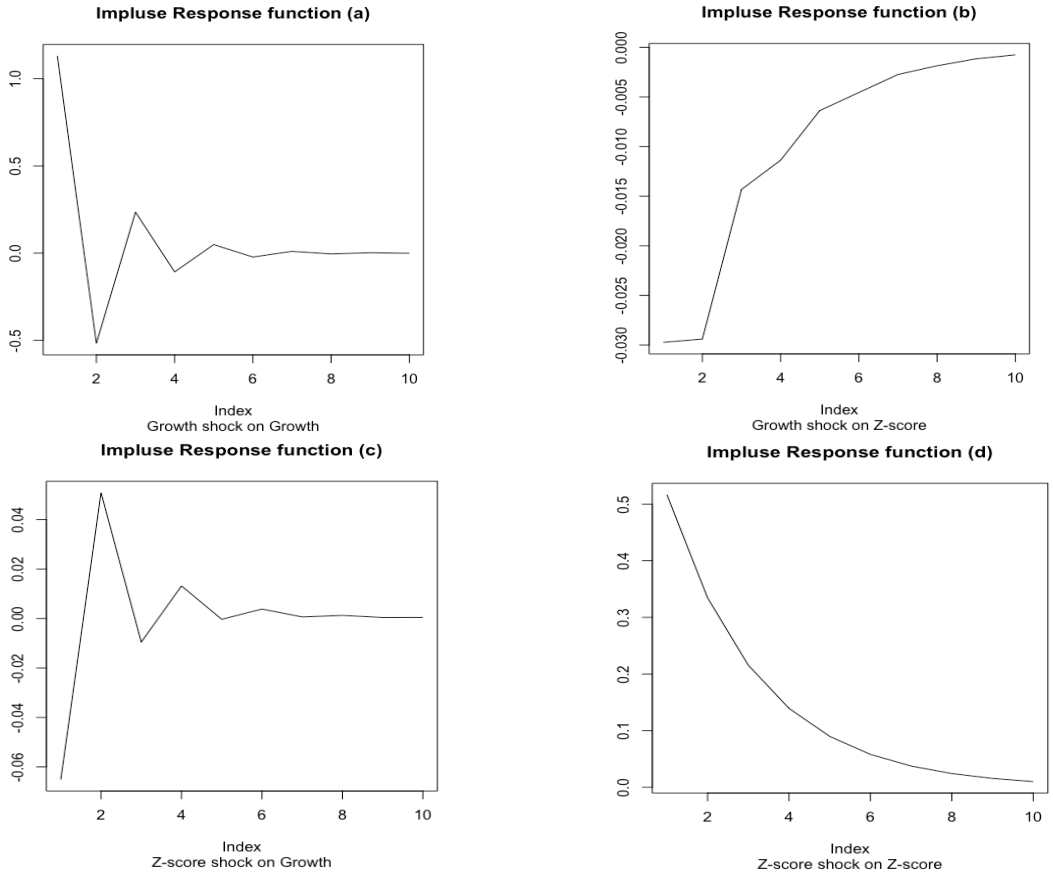

FIGURE A5: NON-LINEAR ESTIMATION OF GROUP 2

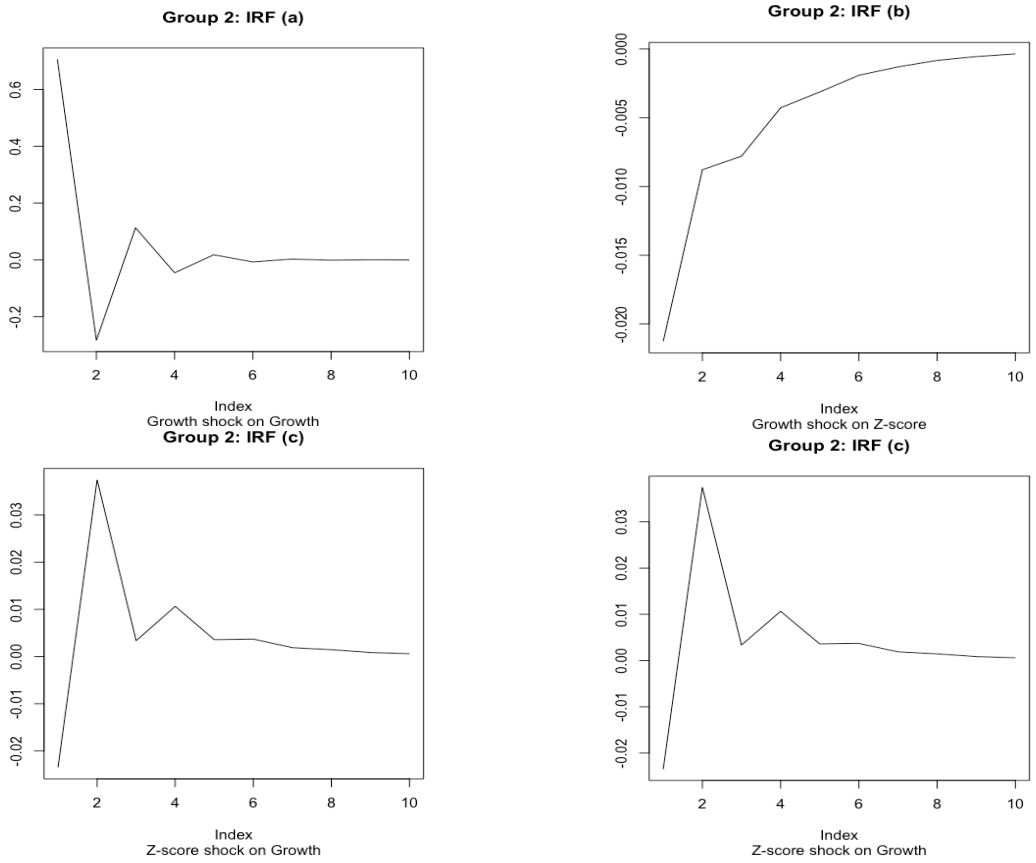

FIGURE A6: NON-LINEAR ESTIMATION OF GROUP 1

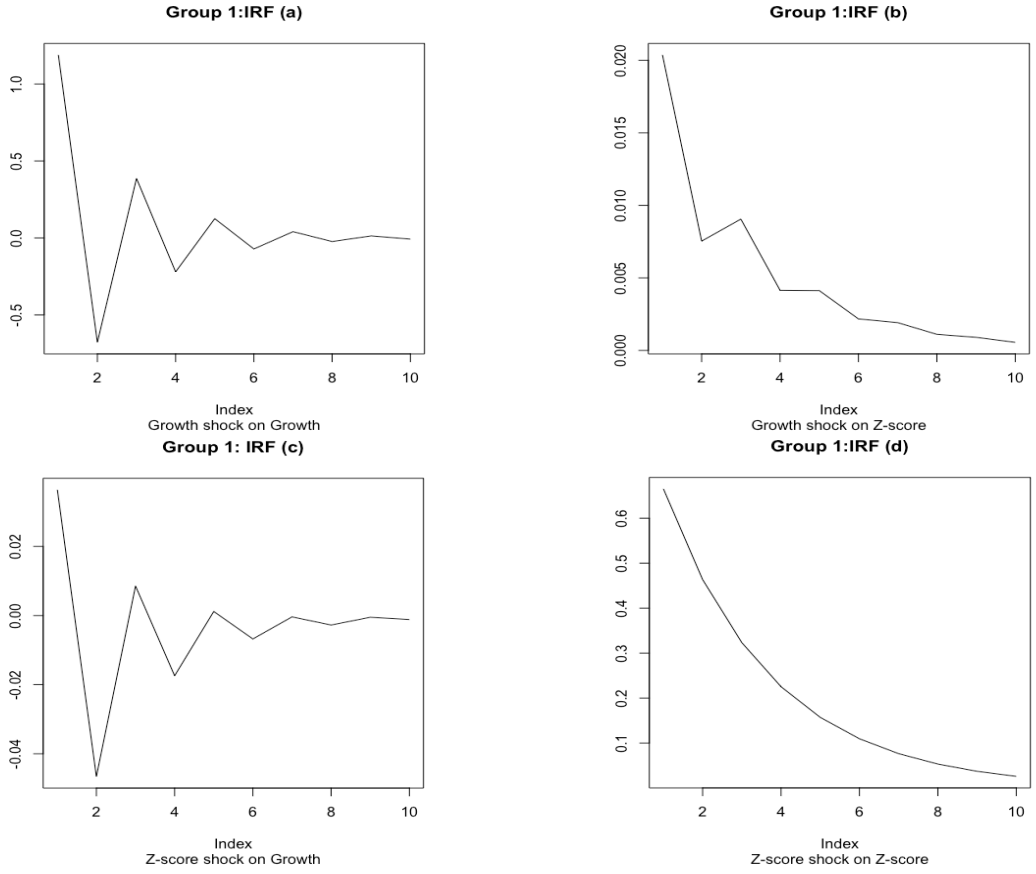

FIGURE A7: IRFS FROM THE NON-LINEAR ESTIMATION FINANCIAL CRISIS – GROUP 1& 2